

## Studies on the Genus *Bolbitis* (Dryopteridaceae) from Vietnam and Laos

JIAN-YING XIANG and WU SU-GONG\*

Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, P. R. China, 650204

PHAN KE LOC

Hanoi University of Science (HUS), VNU, 334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam  
Institute of Ecology and Biological Resources (IEBR), VAST, 18 Hoang Quoc, Viet, Nghia Do, Cau Giay, Hanoi, Vietnam

ONEVILAY SOULIYA

Research Institute of Medical Plants, Ministry of Health, Vientiane, Lao PDR

**ABSTRACT.**—The genus *Bolbitis* from Vietnam and Laos is revised; 14 species and two varieties are recognized. A new species, *Bolbitis lanceolata* S. K. Wu & J. Y. Xiang is described and illustrated. *Bolbitis scandens* W. M. Chu ex Ching et C. H. Wang and *B. yunnanensis* Ching ex Ching et C. H. Wang are two new records in both Vietnam and Laos. *Bolbitis hekouensis* Ching and *B. latipinna* Ching are treated as synonyms for the first time.

**KEY WORDS.**—Bolbitoid ferns, Dryopteridaceae, Vietnam, Laos, taxonomic review

The genus *Bolbitis* was established by Schott in 1834, to include species with a creeping rhizome and anastomosing veins. Simultaneously Schott established *Egenolfia* to describe the species with free veins. The first monograph of the genus *Egenolfia* was completed by Ching (1931), in which nine species and one variety, including two species from Vietnam were recognized. In the *Flore Générale de l'Indo-Chine*, C. Christensen and Tardieu-Blot (1941) described 12 species of *Bolbitis* and *Egenolfia*. Iwatsuki (1959) revised the Japanese species and treated *Egenolfia* as a synonym of *Bolbitis*. In a broader study on *Bolbitis*, Hennipman (1977) accepted Iwatsuki's generic delimitation, completed a taxonomic review for the genus *Bolbitis*, recognized 44 species, among which 12 species and three varieties were distributed in the Indo-China peninsula. Recently, Phan (1998) recorded 14 species (varieties) of *Bolbitis* and two species of *Egenolfia* from Vietnam.

Moran *et al.* (2010a) studied the phylogeny of the bolbitoid ferns using two non-coding chloroplast spacers: *trnL-trnF* and *rps4-trnS* with samples from 57 species. They found that traditionally recognized *Bolbitis* was resolved as polyphyletic, with the Neotropical species sister to *Elaphoglossum*, separate from the other species of *Bolbitis*. Moran *et al.* (2010b) recognized the Neotropical clade as a new genus, *Mickelia*, including 10 species and one hybrid, leaving *Bolbitis* as a pantropical genus of about 50 species.

---

\* Corresponding author, e-mail: sugong@mail.kib.ac.cn



From 2004 to 2008, five botanical expeditions were conducted by the authors in both Vietnam and Laos. Nearly 10,000 specimens were collected during these expeditions, with nearly 250 of them belonging to *Bolbitis*. A taxonomic revision of *Bolbitis* is made accordingly, based on field observations and herbarium study. Based on these studies, 14 species and two varieties from Vietnam and Laos are recognized, including one new species, two new records and two new combinations as follows.

The species reported in our study different from those of Phan (1998) in several ways. *Bolbitis annamensis* Tardieu-Blot & C. Chr. has been subsumed in *B. heteroclita* (Presl) Ching, *B. prolifera* (Fée) C. Chr. & Tard. has been subsumed in *B. virens* (Hook. & Grev.) Schott, and *Egenolfia asplenifolia* Fée has been subsumed in *Bolbitis appendiculata* (Willd.) K. Iwats. as Hennipman (1977) suggested. *Bolbitis cadieri* (C. Chr.) Ching, which was suggested by Hennipman (1977) as a possible hybrid, has not been seen in our fieldwork. *Bolbitis crispatula* (Copel.) Ching var. *copelandii* (Ching) Hennipman is accepted as *B. copelandii* Ching ex C. Chr. & Tardieu. Two new records are here reported, *Bolbitis scandens* W. M. Chu ex Ching et C. H. Wang and *B. yunnanensis* Ching ex Ching et C. H. Wang. *Bolbitis semicordata* (Bak.) Ching is a species distributed in South India, we have not seen it and doubt the validity of the record. *Egenolfia sinensis* (Bak.) Maxon should be *Bolbitis sinensis* (Baker) K. Iwats. *Bolbitis prolifera* (Fée) C. Chr. & Tard. has been subsumed in *B. virens* as Hennipman suggested.

KEY TO THE SPECIES OF *BOLBITIS* IN VIETNAM AND LAOS

- 1. Veins free
  - 2. Perispore reticulate; lateral pinnae subentire or crenate, apex obtuse or acute
    - 3. Stipe and rachis subglabrous; base of pinnae asymmetrical; fertile pinnae ovate or oblong . . . . . ***B. appendiculata***
    - 3. Stipe and rachis densely scaly; base of pinnae symmetrical; fertile pinnae moniliform. . . . . ***B. hookeriana***
  - 2. Perispore cristate-undulate; lateral pinnae pinnatifid, apex acuminate
    - 4. Stipe scaly at the base, rachis and costa very sparsely scaly; lateral sterile pinnae less than 20 pairs; pinnae subentire or shallowly lobed . . . . . ***B. sinensis***
    - 4. Stipe, rachis and costa underneath densely scaly; lateral sterile pinnae more than 30 pairs; pinnae lobed more than halfway towards the costa. . . . . ***B. tonkinensis***
- 1. Veins more or less anastomosing
  - 5. Areoles with free included veinlets
    - 6. Veins forming a costal areole, otherwise free; terminal segment similar to the lateral ones
      - 7. Fertile pinnae more or less pteridoid, sporangia inserted along the margin only. . . . . ***B. copelandii***
      - 7. Fertile pinnae acrostichoid, sporangia inserted all over the lower surface. . . ***B. crispatula***
    - 6. Veins forming 2 to more areoles
      - 8. Terminal segment similar to the lateral ones. . . . . ***B. yunnanensis***
      - 8. Terminal segment different from the lateral ones
        - 9. Fronds in 2 series on rhizome, terminal segment  $\pm$  conform to the pinnae. . . . . ***B. heteroclita***
        - 9. Fronds in 3 series on rhizome, terminal segment triangular. . . . . ***B. christensenii***
  - 5. Areoles lacking free included veinlets
    - 10. Rhizome high climbing, up to 2 m. . . . . ***B. scandens***
    - 10. Rhizome terrestrial or epiphyte, short-creeping



11. Lamina hard, coriaceous, lustrous when dried, lateral veins regular, obvious on both sides . . . . . *B. viriens*
11. Lamina herbaceous to chartaceous, matte, lateral veins obscure
12. Dried lamina purplish. . . . . *B. scalpturata*
12. Dried lamina greenish
13. Margin of pinnae usually shallowly lobed, rounded or rounded cuneate at the base, terminal segment acute or short-flagelloid. . . . . *B. subcordata*
13. Margin of pinnae entire, narrowly cuneate at the base, terminal segment similar to the lateral ones. . . . . *B. lanceolata*

***Bolbitis appendiculata*** (Willd.) K. Iwats. Acta Phytotax. Geobot. 18: 48. 1959; *Acrostichum appendiculatum* Willd. Sp. Pl. 5: 114. 1810. *Gymnogramma auriculata* Kaulf., Enum. Fil. 79, 1824, non Bl. 1828. *Polybotrya appendiculata* J. Smith, Hook. J. Bot. 4: 150, 1841. *Lacaussadea appendiculata* Gaudich., Voy. Bonite Bot. pl. 119. 1852. *Egenolfia appendiculata* J. Smith, Ferns Br. For., 111, fig. 1866. TYPE.—INDIA. Klein 912, without precise locality (B).

*Acrostichum asplenifolium* Bory in Bélanger, Voy. Ind. Or. Bot. 2: 21, pl. 3. 1833. *Polybotrya asplenifolia* Presl, Tent. Pterid. 231, 1836. *Polybotrya appendiculata* (Willd.) J. Smith var. *asplenifolia* Bedd., Handb. Ferns Br. India: 424. fig. 255. 1883. *Egenolfia asplenifolia* Fée, Genres Polyp.: 358. 1852. *B. asplenifolia* Iwatsuki, Acta Phytotax. Geobot. 18: 49. 1959. TYPE.—INDIA. Bélanger s.n., South India, Madura, Dendigal, 1831 (P).

*Egenolfia crenata* Ching & Chiu, Acta Phytotax. Sin. 21:212. 1983. TYPE.—CHINA. **Yunnan:** Jinping, *Sino-USSR Yunnan Exped.* 892 (Holotype: PE; isotype: KUN).

SPECIMENS EXAMINED.—LAOS. **Bolikhamsai Province:** Kham Keuete District, Thong Pei Village, Phou Koma, 18°18'104"N, 109°09'28"E, 600–650 m, Nov. 3, 2007, Wu, Liu, et al. 219 (IEBR, KUN). **Champasak Province:** Parson District, Nang long Village, Dasta Waterfall, 1100–1200 m, Dec. 17, 2008, Wu, Gong, et al. 2124 (GH, KUN, MO, TMRC). **Vientiane Province:** Vang Vieng District, Na Mouang Village, 18°53'293" N, 102° 25'183" E, 230–300 m, Nov. 14, 2007, Wu, Liu, et al. 392 (KUN, TMRC). VIETNAM. **Đắk Nông Province:** Dak Gloong District, Dak P'lao Commune, Ta Dung Nature Reserve, approximately 18°52'18" N, 108°01'37" E, 1200–1400 m, Nov. 13, 2006, Wu, Phan, et al. 1525 (GH, IEBR, KUN, MO). **Hà Giang Province:** Yen Minh District. Du Gia Mun., about 2 km to SW Giang Tru C Village, approximately 22°56'51" N, 105°10'24" E, 900–1200 m, Nov. 29, 2004, Wu, Phan, et al. 788 (GH, IEBR, KUN, MO); Yen Minh District, Du Gia Mun., about 2 km to Sw Giang Tru C Village, 22°56'51" N, 105°10'24" E, 1000–1200 m, Nov. 30, 2003, Wu, Phan, et al. 832 (IEBR, KUN, MO). **Kon Tum Province:** Kon Plong District, Po E Mun., Violac Village, 14°45' 16" N, 108°30' 41"E, 900–1000 m, Nov. 22, 2003, Wu, Phan, et al. 188 (GH, IEBR, KUN, MO). **Quảng Bình Province:** Bo Trach



District, Hung Trach Mun., Phong Nha-Ke Bang National Park, ca. 650 m, between km 51–56 of west branch of Ho Chi Minh road, approximately 17°27'30" N 106°23'06" E, Dec. 07, 2004, *Wu, Phan, et al.* 929 (GH, IEBR, KUN, MO); Bo Trach District, Tan Trach Mun., ca. 750 m, km 37 of the road No. 565, approx. 17°24'24" N, 106°13'08" E, Dec. 13, 2004, *Wu, Phan, et al.* 1118 (GH, IEBR, KUN, MO).

DISTRIBUTION.—Japan (Ryukus), China (South), India, Thailand, Cambodia, Laos, Vietnam, Malaysia. Very common in South Asia.

ECOLOGY.—In dense forest, usually along the stream on muddy rocks, 250–1400 m.

*Bolbitis christensenii* (Ching) Ching in C. Chr. Ind. Fil., Suppl. 3: 47. 1934. *Campium christensenii* Ching, Bull. Fan Mem. Inst., Biol., Bot. Ser. 2: 214, pl. 31. 1931. TYPE.—CHINA. Kweichow, Puding, *Esquirol* 2672 (K?).

*Bolbitis hekouensis* Ching, Acta Phytotax. Sin. 21: 212. 1983. TYPE.—CHINA. **Yunnan:** Hekou, *S. K. Wu* 4056 (PE).

SPECIMENS EXAMINED.—LAOS. **Bolikhamsai Province:** Kham Keuate District, Phou Kom, Thong Pei Village, 18°18'104" N, 109°28'00" E, 600–650 m, Nov. 3, 2007, *Wu, Liu, et al.* 199 (KUN, TMRC). VIETNAM. **Hà Giang Province:** Yen Menh District, Du Gia Mun., about 1 km to SW Giang Tru C Village, 22°56'51" N, 105°10'24" E, 500–850 m, Nov. 28, 2004, *Wu, Phan, et al.* 763 (IEBR, KUN).

DISTRIBUTION.—China (Yunnan), Thailand, Vietnam. New record for Laos.

ECOLOGY.—In primary and secondary evergreen broad-leaved forest or scrub in limestone area.

*Bolbitis copelandii* Ching ex C. Chr. & Tardieu. Notul. Syst. (Paris) 7: 101. 1938. *Bolbitis crispatula* (Copel.) Ching var. *copelandii* (Ching) Hennipm., Leid. Bot. Ser. 2: 159. f. 40: 1, 42. 1977. TYPE.—CAMBODIA. Angkor, *H. M. Smith* 302 (Holotype: BM, isotype: MICH, US).

SPECIMENS EXAMINED.—LAOS. **Attapeu Province:** Xaysetha District, Dachen Village, Dec. 9, 2008, *Wu, Gong, et al.* 1989 (GH, KUN, MO, TMRC). **Khammouane Province:** Hinboun District, Naxin Village, Tad Nam Sanam Waterfalls, 18°14'00" N, 104°42'234" E, Nov. 8, 2007, *Wu, Liu, et al.* 319 (GH, KUN, MO, TMRC); Gnommalate District, Houay Jat Mountain, Keovilay Village, 17°40'154" N, 105°10'908" E, Oct. 28, 2007, *Wu, Liu, et al.* 52 (GH, KUN, MO, TMRC). **Saravane Province:** Tateng District, Panentay Village, Dec. 3, 2008, *Wu, Gong, et al.* 1808 (GH, KUN, MO, TMRC); Tateng District, Songtia Village, TormaHore Waterfall, Dec. 4, 2008, *Wu, Gong, et al.* 1860 (GH, KUN, MO, TMRC); Lao gham District, Nasia Village, Dec. 14, 2008, *Wu, Gong, et al.*



2055 (GH, KUN, MO, TMRC). **Vientiane Province:** Vang Vieng District, Na Khoum Village, 18°52'465" N, 102°24'384" E, Nov. 13, 2007, *Wu, Liu, et al.* 361 (GH, KUN, MO, TMRC). **VIETNAM. Đồng Nai Province:** Tan Phu District, Nam Cat Tien Commune, Cat Tien National Park, 11°26'57" N, 107°21'41" E, Nov. 17, 2006, *Wu, Phan, et al.* 1642 (GH, IEBR, KUN, MO).

**DISTRIBUTION.**—Thailand, Laos, Vietnam. A common species, especially in South Laos.

**ECOLOGY.**—In primary and secondary evergreen forest, 200–800 m.

**DISCUSSION.**—This species was treated as a variety of *Bolbitis crispatula* by Hennipman (1977). Tagawa & Iwatsuki (1988) treated it at the rank of species and pointed out that *B. crispatula* has narrow fertile fronds, 2–5 mm wide, covered almost entirely with sporangia, while *B. copelandii* have wider fertile fronds, 4–12 mm, bearing the sporangia in a broad band near the margins often curving along the lobes and dispersing inwards below the sinus, and with a broad sterile portion on both sides of the costae.

***Bolbitis crispatula*** (Copel.) Ching in C. Chr. Ind. Fil. Suppl. 3: 47. 1934; *Acrostichum crispatulum* (Wall.) C.B. Clarke, Trans. Linn. Soc. Bot. 1: 580, pl. 84, fig. 2B, 2D, 1880. excl. var. nom. illeg., non Fée 1852. **TYPE.**—**BANGLADESH.** Kumaon, *Wallich* 24 p.p. (Blinkworth leg.), (Holotype: K, herb. Wallich; isotype: K, MICH.).

**SPECIMEN EXAMINED.**—**LAOS. Sekong Province:** Tateng District, Songtia Village, Torma Hore Waterfall, Dec. 4, 2008, *Wu, Gong, et al.* 1860 (GH, KUN, MO, TMRC).

**DISTRIBUTION.**—India, Thailand and Vietnam. New record for Laos.

**ECOLOGY.**—In tropical semi-deciduous forest, 500–600 m.

**DISCUSSION.**—*Bolbitis crispatula* is most similar to *B. copelandii* Ching ex C. Chr.; see discussion under *B. copelandii*.

***Bolbitis heteroclita*** (C. Presl) Ching ex C. Chr. Ind. Fil., Suppl. 3: 48. 1934. *Acrostichum heterocilitum* C. Presl, Rel. Haenk. 1: 15. pl. 2:2. 1825. *Leptochilus heterocilita* (C. Presl) C. Chr. Ind. Fil. 385. 1906. **TYPE.**—**INDONESIA. West Java:** Mt. Salak, Tjikoja, *Zollinger* 1441, (Holotype: P; isotype: BM, G).

***Bolbitis annamensis*** Tardieu & C. Chr., Not. Syst. 7:100. 1938. **TYPE.**—**VIETNAM.** Annam, Thanh Tan, 100–200m, *Cadière* 149 (Holotype: BM; isotype: P).

***Bolbitis confertifolia*** W. M. Chu ex Ching et C. H. Wang, Acta Phytotax. Sin. 21: 211. 1983. **TYPE.**—**CHINA. Yunnan:** Xishuangbanna, *Yunnan Complex Exped.* 1851. (PE).



SPECIMENS EXAMINED.—LAOS. **Vientiane Province:** Vang Vieng District, Na Khoum Village. 18°52' 465" N, 102° 24' 354" E, 250 m. Nov. 13, 2007, *Wu, Liu, et al.* 355 (GH, KUN, MO, TMRC). VIETNAM. **Hà Giang Province:** Yen Minh District, Du Gia Mun., about 2 km to SW of Giang Tru C Village, approximately 22°56'51" N, 105°10'24" E, 900–1200 m, Nov. 29, 2004, *Wu, Phan, et al.* 769 (GH, IEBR, KUN, MO). **Quảng Bình Province:** Bo Trach District, Hung Trach Mun., Phong Nha-Ke Bang National Park, ca. 650 m, between km 51 and 56 of west branch of Ho Chi Minh road, approximately 17°27'30" N, 106°23'06" E, Dec. 7, 2004, *Wu, Phan, et al.* 894 (KUN); Bo Trach District, Xuan Trach Mun., Phong Nha-Ke Bang National Park, arounda Deo pass, ca. 460 m, about 25 km to the north of Khe Gat. along Ho Chi Minh road. approximately 17°39'24" N, 106°05'66" E, Dec. 8, 2004, *Wu, Phan, et al.* 937 (GH, IEBR, KUN, MO).

DISTRIBUTION.—China, North India, Burma, Thailand, Malaysia to New Guinea. New record for Laos and Vietnam.

ECOLOGY.—In disturbed primary and secondary broad-leaved lowland and submontane forests, and it prefers very moist habitats, usually growing along the stream, 150–1200 m.

DISCUSSION.—Tagawa and Iwatsuki (1988) reported that “This species does not form colonies like *Bolbitis subcordata* of Japan”; however, we do find large colonies of *B. heteroclita* in Vietnam. In some colonies, particularly in very moist habitats, vegetative propagation is common, and almost no fertile fronds can be found.

***Bolbitis hookeriana*** K. Iwats. in Acta Phytotax. Geobot. 18: 59. 1959. *Polybotrya vivipara* Buch.-Ham. Fl.: t. 107. 1825. *Egenolfia vivipara* (Buch.-Ham.) C. Chr. Ind. Fil., Suppl. 111: 102. 1934. *Bolbitis appendiculata* ssp. *vivipara* var. *vivipara* (Hook.) Hennisman in Blumea 18: 147. 1970. TYPE.—INDIA. *Wallich 29 p.p.* (Hamilton leg), Assam, Goalpara, 1808 (Holotype: K, isotype: K).

SPECIMENS EXAMINED.—LAOS. **Khammouane Province:** Nhommalat District, Tha Thote Village, Oct. 27, 2007, *Wu, Liu, et al.* 16 (GH, KUN, MO, TMRC). VIETNAM. **Đồng Nai Province:** Tan Phu District, Nam Cat Tien Commune, Cat Tien National Park, approximately 11°26'57" N, 107°21'41" E, ca.115 m, Nov. 17, 2007, *Wu, Phan, et al.* 1644 (GH, IEBR, KUN, MO).

DISTRIBUTION.—North India, Thailand. New record for Laos and Vietnam.

ECOLOGY.—In broad-leaved dense forest, usually along the stream on muddy rocks, 150–1000 m.

***Bolbitis lanceolata*** S. K. Wu & J. Y. Xiang, *sp. nov.* TYPE.—LAOS. **Khammoun Province:** Nakai District, Nakai Village, Phou Ar. (Dan Feuung), 17°43'217" N, 105°07'663" E, in evergreen forest, on limestone rocks, 650–750 m, Oct. 31, 2007, *Wu SG, Liu ED, Xiang JY, Somsanith B, Onevilay S 121* ( KUN, MO, TMRC). **Fig. 1: A–C, Fig. 2.**



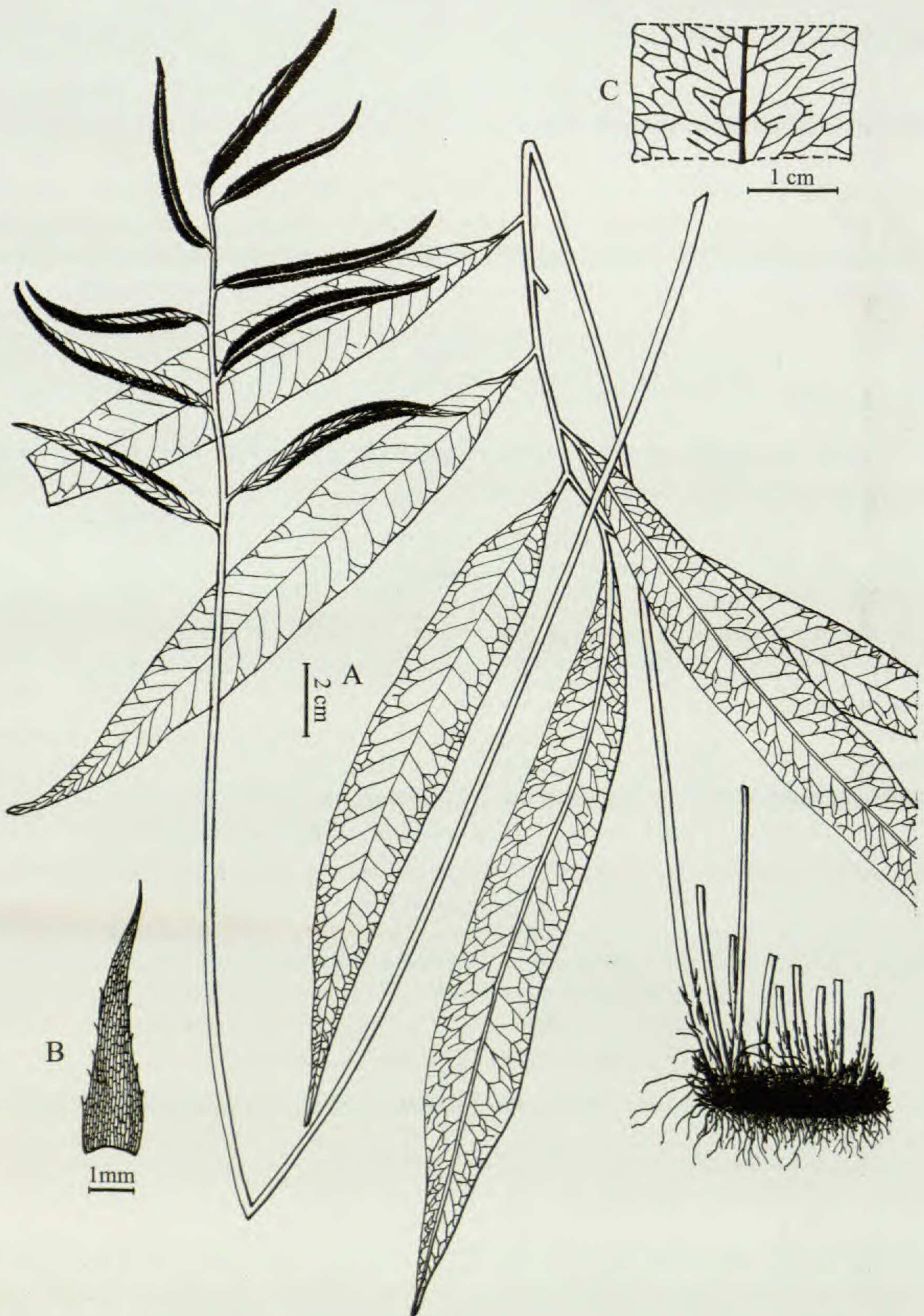


FIG. 1. *Bolbitis lanceolata* S. K. Wu & J. Y. Xiang. A) habitat; B) Rhizome Scale. C) Part of sterile pinna. Drawn from Wu, Liu, et al. 336 (KUN).



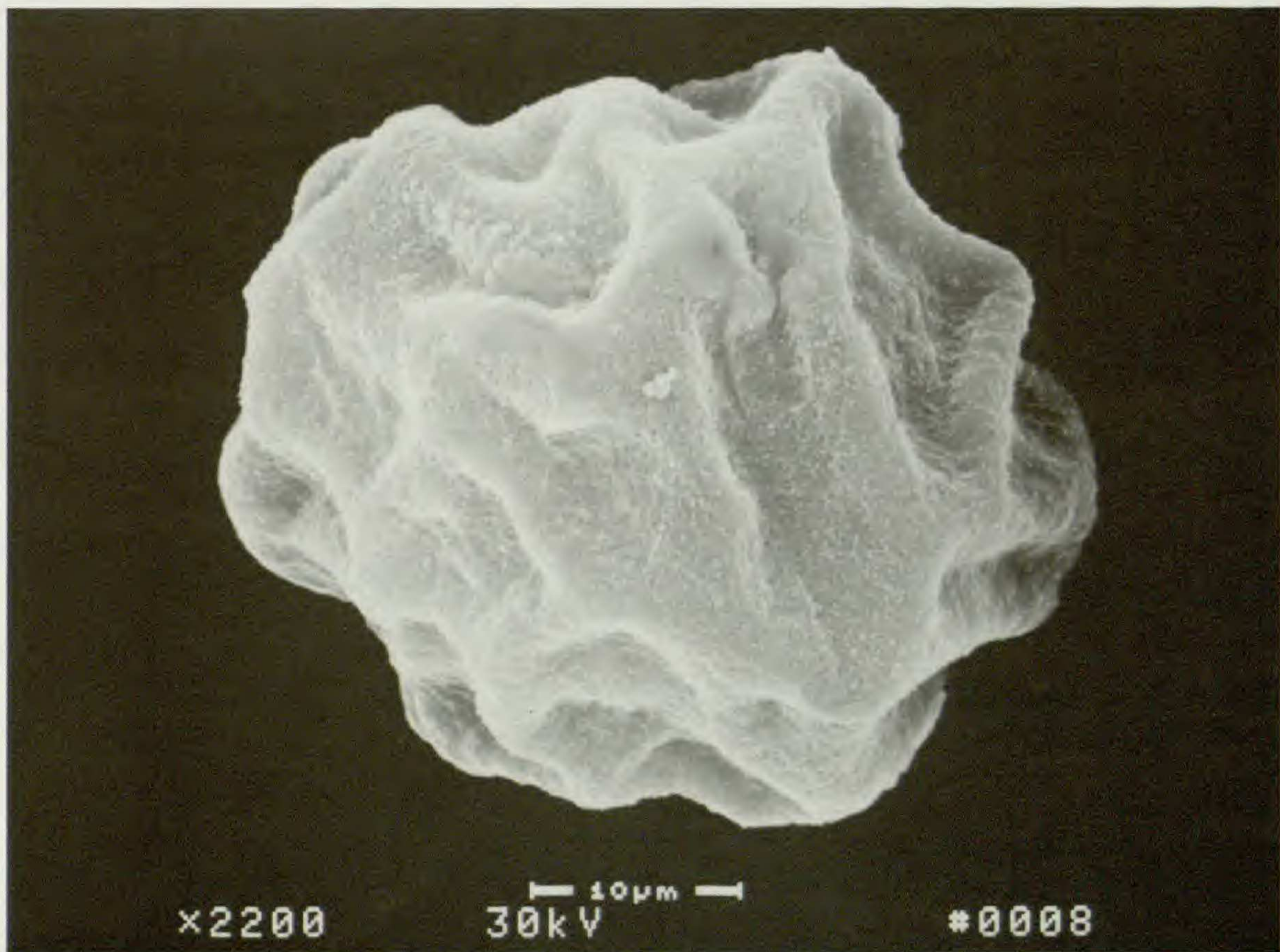


FIG. 2. Scanning electron micrograph of a spore of *Bolbitis lanceolata*. Taken from Wu, Liu, et al. 121 (KUN).

*Bolbitidi scalptulatae* (Fée) Ching similis, sed frondibus 3–4 seriebus, approximatis, pinnis sterilibus angustioribus 15–20 × 2–2.5 cm, pinnis lateralibus 3–5-jugis, lanceolatis, basi acuminatis, margine integris, dilute chartaceis, in sicco viridulis non rubescentibus, pinna terminali ad apicem sine bulbilo differt.

Terrestrial. Rhizome short-creeping, up to c. 10 cm long, 5–10 mm thick, with 3 or 4 rows of leaves. Rhizome scales subclathrate, oblanceolate, 2–3 × 0.5–1 mm, entire or irregularly lacinate at margin, brown, clathrate. Roots ventral, irregularly arranged. Leaves rather close together. Fronds dimorphic, 40–70 cm long, stipe stramineous, 25–30 cm long, grooved on the adaxial side, with scales at the base, gradually becoming glabrous towards the apex. Sterile lamina ca. 25–30 cm long, 20–25 cm wide, pinnate, 3–5 pairs of pinnae, pinnae alternate, lanceolate, 15–20 × 2–2.5 cm, apex caudate, base acuminate, margin entire, short-stalked, patent or ascending. Lamina papyraceous, green when dried, glabrous, terminal segment similar to the lateral ones, without bulbil on the adaxial surface. Veins raised abaxially, immersed adaxially, main lateral veins 4–6 mm apart, with two or three rows of areoles between two adjacent lateral veins, with one or two included veinlets in each areole. Fertile lamina ca. 40–70 × 3–8 cm, petiole 25–40 cm, lateral pinnae 3–4 pairs, linear-lanceolate, 2.5–7 × 0.3–0.7 cm, stalked 1–2 mm. Sporangia distributed evenly



over the lower surface. Spores monolete, spheroidal, undulate with gross ridges.

**SPECIMENS EXAMINED.**—**LAOS. Khammouane Province:** Hinboun District, Khounkham Village, Houay Muang (Phou Hai), 18°13'469"N, 104 °32'671" E, in broad-leaved evergreen forest, limestone rocks, 450–500 m, Nov. 9, 2007, *Wu, Liu, et al.* 336 (Holotype: KUN, isotype: TMRC).

*Bolbitis lanceolata* is most similar to *Bolbitis sculpturata* (Fée) Ching, but differs by having 3 to 4 rows of leaves close together; pinnae of sterile lamina narrower, 15–20 × 2–2.5 cm, lateral pinnae 3–5 pairs, pinnae base cuneate, entire at margin, thin-chartaceous, greenish when dry, without bulbil at the apex of the terminal pinnate. In contrast, *Bolbitis sculpturata* has 2 rows of spaced leaves, pinnae of sterile lamina wider, 15–20 × 3–4 cm, lateral pinnae 5–7 pairs, pinnae base acuminate pinnae margin more or less serrate-crenate, herbaceous to subcoriaceous, purplish or purplish-brown when dry, with or without bulbil at the apex of the terminal pinnate.

**ECOLOGY.**—This species is endemic to Khammoun Province of Laos, where it is epipetric under the broad-leaved evergreen forest on limestone mountain.

***Bolbitis sculpturata*** (Fée) Ching in C. Chr. Ind. Fil. Suppl. 3: 50 1934. *Heteroneuron sculpturatum* Fée, Hist. Acrost. 95, pl. 56. 1845. *Acrostichum sculpturatum* Kunze, Bot. Zeit. 103, 1848. Mettenius, Fil. Lips. 21, 1856. *Leptochiilus sculpturatus* C. Chr., Ind. Fil. 387, 1906. *Campium sculpturatum* Copel., Philip. J. Sc. 37: 383, f. 35. 1928. **LECTOTYPE.**— (Chosen by Hennipman, 1977). **PHILIPPINES.** Manila, xi-1836, *Gaudichaud s.n.* (Holotype: P ; isotype: B, BM, P.).

**SPECIMENS EXAMINED.**—**LAOS. Salavane Province:** Lao Gham District, Phu Sa Sat protected area, Nasia Village, 750–800 m, Dec. 14, 2008, *Wu, Gong, et al.* 2057 (GH, KUN, MO, TMRC). **VIETNAM. Đắk Nông Province:** Dak Gloong District, Ta Dung, Dak. P'lao Commune, National Reserve, 11°52'18" N, 108°01'37" E, 1200–1400 m, Nov. 13, 2006, *Wu, Phan, et al.* 1526 (GH, IEBR, KUN, MO).

**DISTRIBUTION.**—Burma, Malaysia, Thailand, Laos, Vietnam.

**ECOLOGY.**—Epipetric on granite, in primary evergreen tropical forest.

***Bolbitis scandens*** W. M. Chu ex Ching & C. H. Wang, Phytotax. Sin. 21: 213. 1983. **TYPE.**— **CHINA. Yunnan:** Lu Chun, *W. M. Chu et al.* 6733 (Holotype: PYU ; isotype: PE)

**SPECIMENS EXAMINED.**—**LAOS. Attapeu Province:** Xaysetha District, Dakcheng Village, 150–200 m, Dec. 7, 2008, *Wu, Gong, et al.* 1929 (KUN, TMRC). Vientiane Province, Vieng District, Na Khoum Village, 18°52'465" N, 102°24'354" E, Nov. 13, 2007, *Wu, Liu, et al.* 355 (KUN, MO, TMRC, GH).

**DISTRIBUTION.**—China (South Yunnan). New record for Laos.



ECOLOGY.—under broad-leaved evergreen forest, along small streams, 1500–2000 m.

DISCUSSION.—This species is closely related to *Bolbitis heteroclita*, differing by its hemiepiphytic habit, having a rhizome that climbs high upon tree trunks. Its leaf texture is chartaceous, thicker than the herbaceous lamina of *B. heteroclita*, and its terminal pinnae never obviously prolonged like *B. heteroclita*.

***Bolbitis sinensis*** (Baker) K. Iwats. Acta Phytotax. Geobot. 18: 49. 1959. *Acrostichum sinense* Baker in Kew. Bull. 14. 1906. *Polybotrya sinensis* C. Chr. Ind. Fil., Suppl. 1: 57. 1913. *Egenolfia sinensis* (Baker) Maxon, Proc. Biol. Soc. Wash. 36: 173. 1923. *Campium sinense* C. Chr., Contr. U.S. Nat. Herb. 26: 292, 1931. TYPE.—CHINA. **Yunnan:** Szemao, *Henry 12494*, (Holotype: K; isotype: B, BM, US).

*Egenolfia bipinnatifida* J. Sm., Hist. Fil. 132. 1875. TYPE.—MYANMAR. **Tanintharyi Region:** Dawna Range near Moulmein, *Parish 60* (K).

SPECIMENS EXAMINED.—LAOS. **Champasak Province:** Parson District, Nanglong Village, Dasta Waterfall, Dec. 17, 2008, *Wu, Gong, et al. 2124B* (GH, KUN, MO, TMRC). **Vientiane Province:** Khamkeut District. Puang Pu tao Village, 550–650 m, Nov. 6, 2007, *Wu, Liu, et al. 302* (KUN). **Xiangkhouang Province:** Kham District, Tha Village, 1300m, Dec. 21, 2008, *Wu, Gong, et al. 2200* (GH, KUN, MO, TMRC). VIETNAM. **Đắk Nông Province:**, Dak Gloong district, Dak P'iao Commune, Ta Dung Nature Reserve, approximately 11°52' 18" N, 108°01' 37" E, 1200–1400 m, Nov. 12, 2006, *Wu, Phan, et al. 1543* (GH, IEBR, KUN, MO); approximately 11°52' 18" N, 108°01' 37" E, 1100–1250 m, Nov. 13, 2006, *Wu, Phan, et al. 1587* (GH, IEBR, KUN, MO). **Kon Tum Province:** Sa Thay District, Sa Nhon Mun., west of Sa Nhon Forest Protection Station, 14°27' 43" N, 107°45' 52" E, between 800–1000 m, Nov. 17, 2003, *Wu, Phan, et al. 085* (GH, IEBR, KUN, MO); Sa Son Mun., Bar Gok villiage, 14°26' 29" N, 107°42' 44" E, 800–1000 m, Dec. 8, 2004, *Wu, Phan, et al. 937* (GH, IEBR, KUN, MO). **Lâm Đẳng Province:** Da Lat city, Ta Nung Commune, Tran Le agriculture farm, approximately 11°56' 08" N, 108°22' 47" E, alt. 1300–1360m, Nov. 8, 2006, *Wu, Phan, et al. 1468* (GH, IEBR, KUN, MO).

DISTRIBUTION.—China (Yunnan), India, Burma, Cambodia, Thailand, Indonesia. New record for Laos and Vietnam.

ECOLOGY.—In primary tropical broad-leaved evergreen forest.

***Bolbitis subcordata*** (Copel.) Ching in C. Chr. Ind. Fil. Suppl. 3: 50. 1934. *Campium subcordataum* Copel., Philipp. J. Sci. 37: 369, fig. 23, pl. 16. 1928. TYPE.—CHINA. Hainan, *McClure C.C.C. 9436* (Holotype: P?; isotype: BISH, BM, C, MO, P).

SPECIMENS EXAMINED.—VIETNAM. **Đắk Nông Province:**, Dak Gloong District, Dak P'iao Commune, Ta Dung Nature Reserve, 11°52' 18" N, 108°01' 37" E, Nov. 13, 2006, *Wu, Phan, et al. 1544* (GH, KUN, MO, TMRC).



DISTRIBUTION.—Japan, China (Hainan), Thailand, Laos. New to Vietnam.

ECOLOGY.—In primary evergreen tropical forest, 1200–1400 m.

***Bolbitis tonkinensis*** (C. Chr. ex Ching) K. Iwats., Acta Phytotax. Geobot. 18: 49. 1959. *Egenolfia tonkinensis* C. Chr. ex Ching, Bull. Fan Mem. Inst. Biol. Bot. Ser. 2:306 1931. TYPE.—VIETNAM. Tonkin, Lang-son Herb. *École Sup. Agric. & Sylvic. Hanoi 3396* (Colani leg.), (Holotype: BM; isotype: BM, P, PE, UC, US).

SPECIMENS EXAMINED.—LAOS. **Champasak Province:** Parson District, Nanglong Village, Dasta Waterfall, *Wu, Gong, et al. 2124B* (GH, KUN, MO, TMRC).

DISTRIBUTION.—China (South Yunnan), Thailand, Cambodia, Vietnam. New record for Laos.

ECOLOGY.—In primary broad-leaved evergreen forest along stream, 1120–1200 m.

***Bolbitis virens*** (Hook. & Grev.) Schott, Gen. Fil.: ad t. 14. 1834. *Acrostichum virens* [Wall., Cat. No. 1033, nom. nud. 1829.] Hooker & Grev., Ic. Fil. 221. 1831. *Campium virens* Presl., Tent. Pterid. 239, 1836. *Cyrtogonium virens* J. Smith, Hook. J. Bot. 4: 154. 1841. *Heteroneuron virens* Fée. Hist. Acrost. 93. 1845. *Poecilopteris virens* Moore. Ind. Fil. XX. *Gymnopteris virens* Keyserling. Polyp. & Cyath. Herb. Bungeani 33. 1873. *Leptochilus virens* C. Chr. Ind. Fil. 388. 1906. TYPE.—MYANMAR. *Tovag, Wallich 1033* (K).

*Bolbitis latipinna* Ching, Acta Phytotax. Sin. 21: 213. 1983. TYPE.—CHINA. **Yunnan:** Xishuangbanna, Sep. 1936, *C. W. Wang 78807* (PE).

a. Central pinnae of fertile leaves index >15, 8–20 × 0.2–0.9 cm..... **var. *virens***

b. Central pinnae of fertile leaves index 3–8, 4–11.5 × 0.8–2 cm..... **var. *compacta***

***Bolbitis virens* var. *virens***

SPECIMENS EXAMINED.—LAOS. **Salavan Province:** Phu Sa Sat Protect area, Dec. 14, 2008, *Wu, Gong, et al. 2057* (GH, KUN, MO, TMRC). **Champasak Province:** Pak Song District, Lak Sao Village, Yuang Waterfall, Dec. 16, 2008, *Wu, Gong, et al. 2069* (GH, KUN, MO, TMRC). **Vientaine Province:** Van Vieng District, Pha Tang Village, 19°04'180" N, 102°24'433" E, Nov. 15, 2007, *Wu, Liu, et al. 420* (GH, KUN, MO, TMRC). VIETNAM. **Kon Tum Province:** Sa Thay District, Sa Son Mun., Bar Gok Village, 14°26'29" N, 107°42'44" E, Nov. 15, 2003, *Wu, Phan, et al. 35* (GH, IEBR, KUN, MO).

DISTRIBUTION.—China (Southern Yunnan), Bangladesh, India, Burma, Thailand. New record for Laos and Vietnam.



ECOLOGY.—In primary tropical evergreen broad-leaved forest, 1200–1400 m.

DISCUSSION.—A very distinct and locally common species. It is similar to *Bolbitis costata* and *B. subcrenata*. It differs from *B. costata* by its greenish dried leaves whereas the latter has purplish dried leaves. It differs from *B. subcrenata* by there being two or more free veins in costal areoles in *B. virens*, while there are only one or two free veins in costal areoles of *B. subcrenata*, and its “venation pattern reminiscent of that of the meniscioid ferns” (Hennipman, 1977).

***Bolbitis virens* var. *compacta*** Hennipm. *Blumea* 18: 149. 1970. TYPE.—THAILAND. Peninsular Thailand, Nakhon Sri Thammarat, Trang, Khao Chong, 600–1100 m, *Tagawa et al. T. 6802*, (Holotype: L; isotype: India, KYO).

SPECIMENS EXAMINED.—LAOS. **Bolikhamsai Province**: Khamkeut District, Nam Gha Nay Mountain, Thong Pai Village, ca. 550 m, Nov. 4, 2007, *Wu, Liu, et al. 227* (KUN, TMRC). VIETNAM. **Kon Tum Province**: Kon Plon District, Po E Mun., Violac Village, 4°15'16" N, 108°30'41" E, 900–1000 m, Nov. 22, 2003, *Wu, Phan, et al. 195* (KUN). **Quảng Bình Province**: Phong Nha –Ke Bang National Park, 17°27'30" N, 106°23'06"E, ca. 650 m, Dec. 07, 2004, *Wu, Phan, et al. 909* (GH, IEBR, KUN, MO); 17°39'24" N, 106°05'66" E, ca. 460 m, Dec. 08, 2004, Dec. 08, 2004, *Wu, Phan, et al. 950* (GH, IEBR, KUN, MO). Bo Trach District, Hung Trach Mun., top of U Bo pass, 17°28' 36" N, 106°22'39"E, 800–900 m, Nov.15, 2003, *Wu, Phan, et al. 1047* (GH, IEBR, KUN, MO).

DISTRIBUTION.—Malaysia, Thailand, New record for Laos and Vietnam.

ECOLOGY.—In primary and secondary evergreen broad-leaved forest or scrub in limestone area near stream.

DISCUSSION.—Differs from var. *virens* by shorter and broader fertile pinnae (ca. 5–8 × 1–2 cm).

***Bolbitis yunnanensis*** Ching ex Ching & C. H. Wang, *Acta Phytotax. Sin.* 21: 214. 1983. *Bolbitis subcordata* auct non Copel. X. Cheng in C. Y. Wu (ed.), *Fl. Yunn.* 21: 222. 2005. TYPE.—CHINA. **Yunnan**: Xishuangbanna, Mar. 1956. *R.C.Ching, s.n.* (PE).

SPECIMENS EXAMINED.—LAOS. **Champasak Province**: Parson District, Nanglong Village, 1100–1200 m, Dec. 17, 2008, *Wu, Gong, et al. 2138* (KUN). VIETNAM. Cat Tien National Park, approximately 11°26'57" N, 107°21'41" E, ca. 115 m. Nov. 17, 2006, *Wu, Phan, et al. 1643* (GH, IEBR, KUN, MO).

DISTRIBUTION.—China (South Yunnan). New record for both Vietnam and Laos.

ECOLOGY.—In disturbed primary and secondary broad-leaved lowland forest on old alluvial black soil with superficial volcanic rocks.

DISCUSSION.—This species is very close to *Bolbitis virens*, but differs from it in having broad fertile pinnae, 5–8 × 0.8–1.2 cm, sterile pinnate 3–5 pairs, entire



or crenate at margin. This species was placed in synonymy under *B. subcordata* (Copel.) Ching in the Flora Yunnanica (Wu, 2005), but it is obvious that lamina of *B. yunnanensis* is imparipinnate while laminae of *B. subcordata* have a pinnate apices. Morphological study of type specimens, Dong (2005) reduced *Bolbitis yunnanensis* as synonym of *B. hainanensis* Ching & Wang. We however have not seen the type of *B. hainanensis*, and maintain the name here until further study can be undertaken.

#### ACKNOWLEDGMENTS

We are grateful to Professor Yang Yong-Ping for his valuable suggestions on this manuscript. We also thank the Herbarium of Institute of Botany, The Chinese Academy of Sciences (PE) for allowing us to study specimens. The field surveys and research were funded by U. S. National Geographic Society (grant number: 6300-98 and 7312-03), and supported by Kunming Institute of Botany, Chinese Academy of Sciences, with our special thanks to the grant supporters.

#### LITERATURE CITED

- CHENG, X. 2005. Bobitidaceae, Pp. 212-225, in Wu, C. Y., ed. *Flora Yunnanica*. Science Press, Beijing.
- CHING, R. C. 1931. On the genus *Egenolfia* Schott. Bull. Fan Mem. Inst. Biol. Ser 2:297-317.
- HENNIPMAN, E. 1977. *A Monograph of the Fern Genus Bolbitis* (Lomariopsidaceae), Leid. Bot. Ser. No 2:1-330, Leiden University Press.
- HO, P. H. 1991. *An Illustrated Flora of Vietnam*. Mekong Printing, Montréal.
- IWATSUKI, K. 1959. Taxonomic studies of Pteridophyta IV. Emendation of *Bolbitis*, with special reference to the Far Eastern species. Acta Phytotax. Geobot. 18:44-59.
- MORAN, R. C., P. H. LABIAK and M. SUNDUE. 2010a. Phylogeny and character evolution of the bolbitidoid ferns (Dryopteridaceae). Int. J. Plant Sc. 171:547-559.
- MORAN, R. C., P. H. LABIAK and M. SUNDUE. 2010b. Synopsis of *Mickelia*, a newly recognized genus of bolbitidoid ferns (Dryopteridaceae). Brittonia 62:337-356.
- TAGAWA, M. and K. IWATSUKI. 1988. *Bolbitis*. Pp. 310-322, in: Smitinand, T. and Larsen, K., eds. *Flora of Thailand. Part 3. Blechnaceae to Athyriaceae*, 297-480, 1988. Chutima press, Bangkok.
- TARDIEU-BLOT, M. and C. CHRISTENSEN. 1940. Flore Générale de l'Indo-chine. 7:423-438.
- WU, S. H. and C. H. WANG. 1999. Bobitidaceae, Pp. 104-124, in Wu, C. Y., ed. *Flora of Reipublicae Popularis Sinicae*. Science Press, Beijing.